Propensities, Correlations and Metaphysics
Summary Version Sept. 1991

1. Metaphysical blueprint (cp Popper)
   realism
   indeterminism
   Measurement ⇒ indeterministic change.
   This is source of uncertainty relations
   — departure scatter relations
   (cp Time-of-flight for momenta x & p)
   Measurement speed case of Time-evolution,
   which in general is indeterministic
   - cp Spin-projections $\underline{q}$ & $\underline{r}$ which roll over and over in Memory but preserve
   $\underline{q}$ changes det Memory, ~~any~~ indet ~~bits~~ ⇒
   to indefinite after the measurement ~~$\underline{q}$ ⇒ $\underline{r}$~~,
   ~~$\underline{q}$ this change~~ while if we do not measure
   $\underline{q}$ but simply perturb it, the correlations
   don't get eliminated, but change.
   Q. Are such changes Causal?
   If they are ⇒ Motives for S.R.
   - tachyons temporal order of cause-effect
   frame relativity etc.

2. Probabilistic Causality — $\underline{r}$ causes $\underline{q}$ ~~$\underline{q}$ causes $\underline{r}$~~

   Lewis analysis
   $\underline{r} \Box\!\!\rightarrow (Prob(\underline{q}) = p)$
   $\sim \underline{r} \Box\!\!\rightarrow \sim(Prob(a) = p)$
   $\underline{r}$ is earlier than $\underline{q}$ because of perturbation or backtracking

Causal dependence between families of events.

$$\forall \varepsilon_a \forall \varepsilon_n \left[(\underline{\nu} = \varepsilon_n) \Box\!\!\rightarrow (\text{Prob}(\underline{\nu} = \varepsilon_a) = p^{\varepsilon_a}_{\varepsilon_n}) \right]$$

where. $\forall \varepsilon_a$., $p^{\varepsilon_a}_{\varepsilon_n'} \neq p^{\varepsilon_a}_{\varepsilon_n''}$, for $\varepsilon_n' \neq \varepsilon_n''$

In Bell Experiment

$$p^{+1}_{+} = \sin^2 \tfrac{1}{2} \theta_{a2}$$

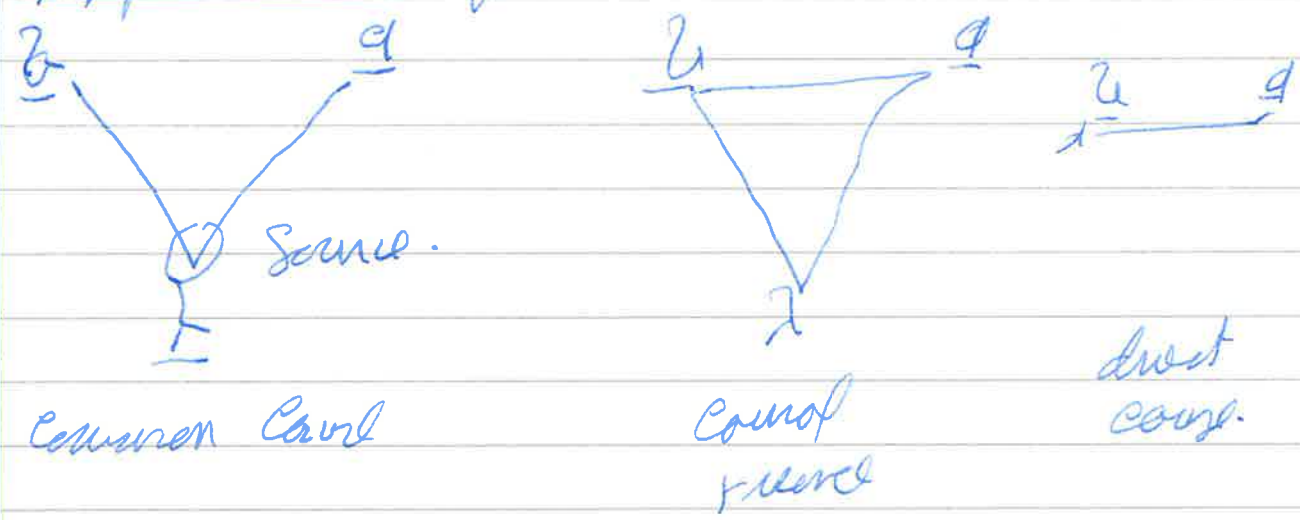
$$p^{-1}_{+1} = \cos^2 \tfrac{1}{2} \theta_{a2}$$

$$p^{+1}_{-1} = \cos^2 \tfrac{1}{2} \theta_{a2}$$

$$p^{-1}_{-1} = \sin^2 \tfrac{1}{2} \theta_{a2}$$

θ_{a2} is angle between $\vec{a}$ and $\vec{\lambda}$.

Explanations of the correlations



common cause

causal influence

direct cause.

Note

Correlations relate events — physical magnitudes taking values

λ a λ can fix all events that could be related causally

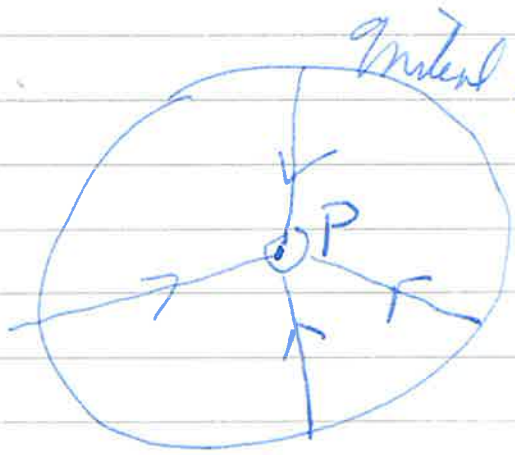
3 De Robustness Condition

Causes produces their effects independently of how they are brought about.

— of Jack's full state ≠ market → explosion

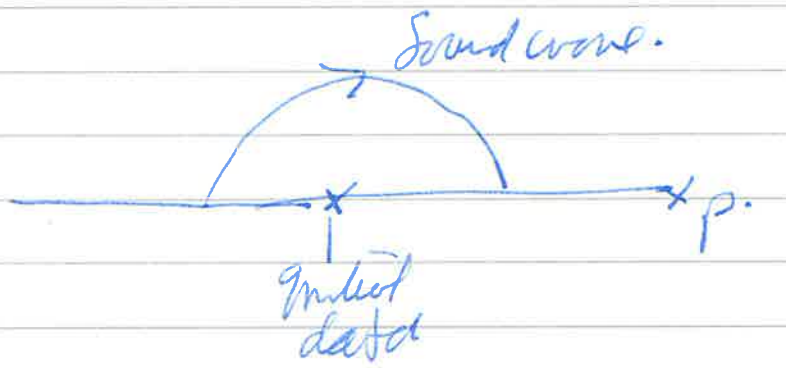
a | Classical Physics Prob(a | b ∧ d) = Prob(a | b)
b *
d * Classical Physics examples

(1) Initial value problem for the scalar wave equation.



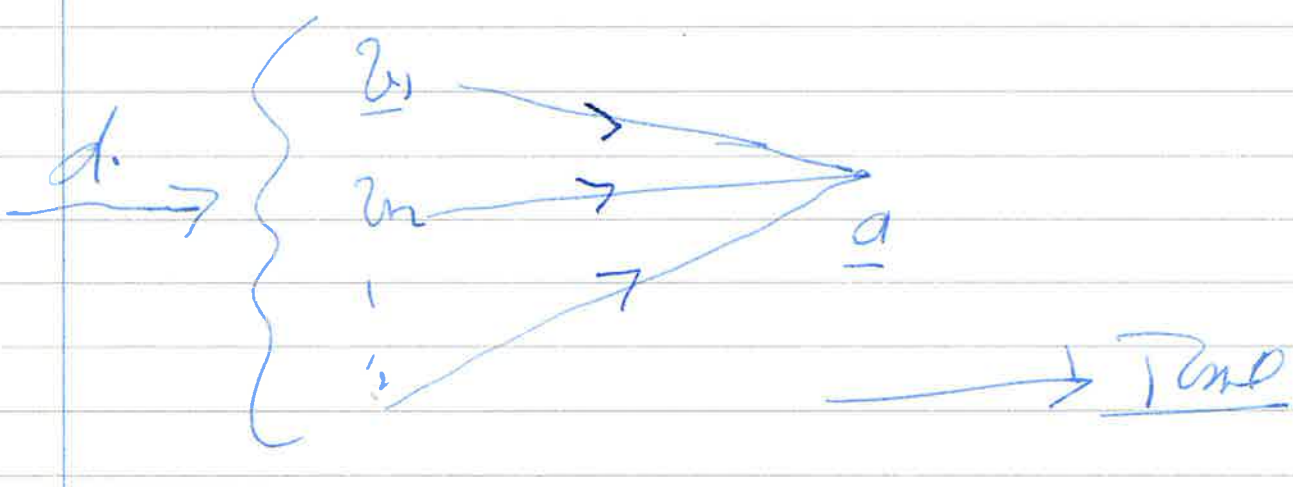
Initial data propagate to produce additive effect amplitude at P.

(2) Vibrating drum head.



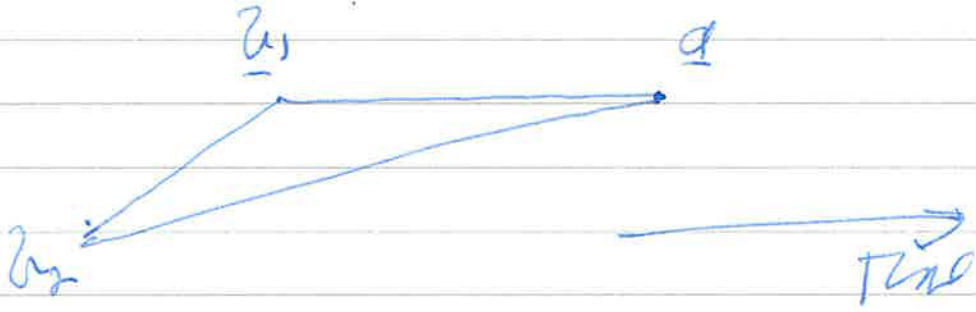
Robustness Condition with Partial Cause

$$Prob(\underline{a} \mid \underline{z_1} \wedge \underline{z_2} \wedge \dots \wedge d) = Prob(\underline{a} \mid \underline{z_1} \wedge \underline{z_2} \dots)$$



Ex:

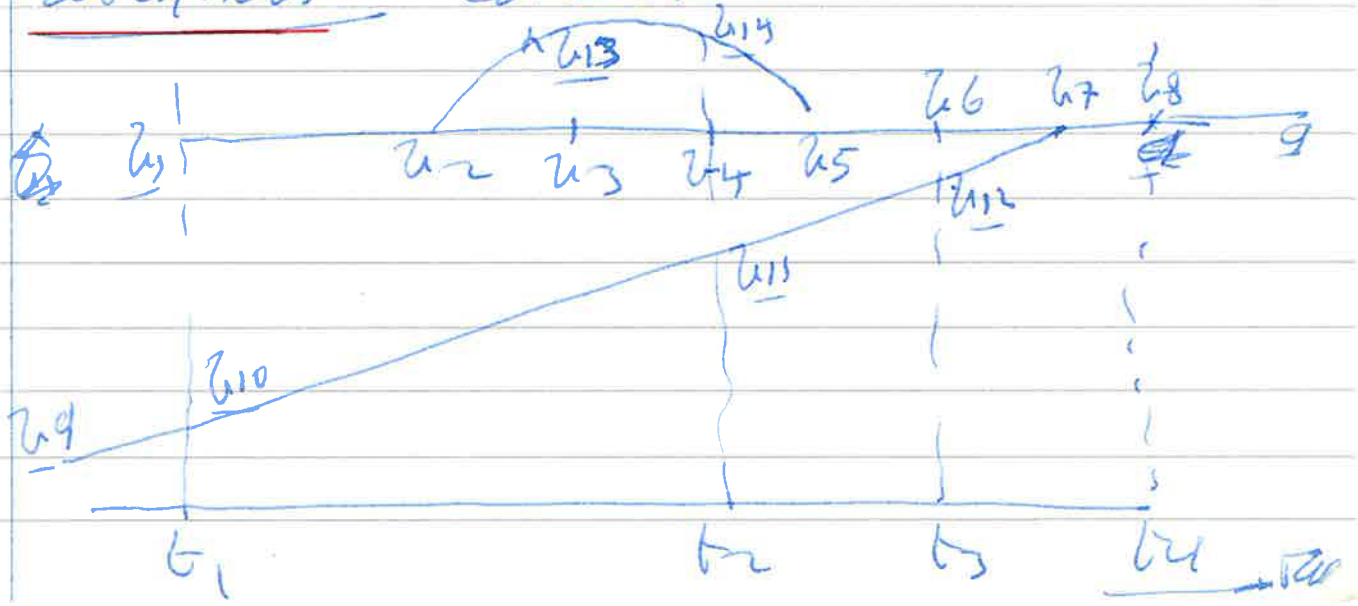
(1)



Note $Prob(\underline{a} \mid \underline{z_1})$ is not robust.

Counterexample to Healy Winn robustness condition:

(2)



Notes (1) Maximal set of partial causes is highly non-unique

(2) We can choose a set which confines events all at the same time — eg hysteresis is not Markovian chains.

Query If Robustness is violated can it always be restored by 'suitably augmenting' the set of partial causes to a 'maximal' set?

Can you try to argue NO from a test eg first if more causes are 'ruled out'. Control Method based operator to look for further causes until Markov/Equil status of whether there are any such.

Related Points

(1) Pearl-Malone used: Total histories are told causes — A Markovian property?

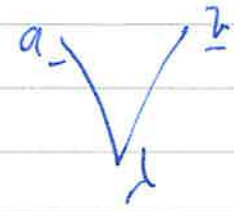
(2) Small disturbances, evidence no longer required

(3) Mach Method not exist — arrows birds example by a lighter mark

4 QM Correlations and Robustness

(1)

$Prob(q \mid c \wedge \lambda)$ is a robust function of its arguments, so both c and λ qualify as partial causes of q (and q and λ are both causes of c!)

(2) 

ruled out by violation of Bell Inequality

(3)

We are here concerned with $Prob^{4}(q \mid c)$

What the proof of non-robustness shows is that $Prob(q \mid c)$ depends on 4.

So should we write

$Prob(q \mid c \wedge 4)$ and regard

4 as another partial cause of q, thus restoring robustness.

But is 4 a coherent fact?

— Depends on the interpretation of 4.

The Catalogue Interpretation 4 as part a catalogue of propensities $Prob(q \mid c)$.

Can a catalogue be a fact?

Contrast Bohm interpretation with 4 a position particle

How can a catalyst cause its entries?

5. Robustness and Signalling

$$Prob(\underline{a} = \xi_a) = \sum_{\xi_b} Prob(\underline{a} = \xi_a | \underline{b} = \xi_b) \times Prob(\underline{b} = \xi_b)$$

If correlation is robust it does not follow that changes $Prob(\underline{b} = \xi_b)$ will necessarily change $Prob(\underline{a} = \xi_a)$

But we can always find changes in $Prob(\underline{b} = \xi_b)$ ~~so~~ that will change $Prob(\underline{a} = \xi_a)$

So no-signalling → non-robustness. Not of any special sort.

In general non-robustness. If a logically weaker condition than no-signalling.
It can also be applied in situations where normal probabilities are not defined at all.

So non-robustness is a more sensitive test. It has non-causal (non no-signalling)

6. Concluding Remark

So [illegible] metaphysical picture as one in which volition and understanding combine with passion rather than action, if I can put it that way.